

Attorney's Docket No. 38190/267786

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Edward Litwinski, Rahmatollah F. Toosky	Confirmation No.:	9632
Appl. No.:	10/631,907	Group Art Unit:	3677
Filed:	July 31, 2003	Examiner:	Flemming Saether
For:	RIVETS HAVING HIGH STRENGTH AND FORMABILITY		

March 31, 2005

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

DECLARATION UNDER 37 C.F.R. § 1.131

Sir:

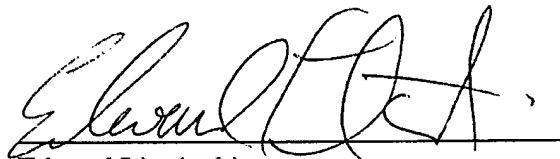
We, Edward Litwinski and Rahmatollah F. Toosky, hereby declare and state that:

1. We are the inventors of the claimed invention of the above-identified U.S. Patent Application Serial No. 10/631,907.
2. On or before October 23, 2001, we produced and tested slug rivets as described below, thereby reducing to practice our invention as described and claimed in the subject application, which is generally directed to a method of manufacturing rivets having high strength and formability. Attached as Exhibit A is a copy of a data summary sheet and four graphs as evidence of our reduction to practice before October 23, 2001. Each of the four graphs illustrates stress versus strain characteristics of two specimens prepared according to the present invention, and the data summary sheet includes the test results for all of the eight specimens. The test specimens were produced by (a) providing a plate of aluminum alloy, (b) friction stir welding a portion of the plate to form a refined grain structure in the portion of the plate, (c) cutting a strip-shaped blank from the refined portion of the plate, (d) machining the blank to form a cylindrical rod, and (d) cutting the

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rod at successive increments along its length to form a plurality of cylindrical specimens, each specimen having the cylindrical shape of a slug rivet. During testing, each specimen was loaded into a fixture defining a cylindrical orifice such that a portion of the specimen extended from the orifice. The extending portion was then compressed toward the fixture, thereby deforming the extending portion to form a head having a diameter greater than the rest of the specimen. A copy of the deformed specimens appears on each graph of the shear test results. (The deformed specimens are disposed in the orifices of the fixtures.) Each of the tests was conducted prior to October 23, 2001, and the four graphs were also prepared before that date. Photographs of the same specimens are included in Appendix B. The photographs were taken after October 23, 2001. The test results are also described on page 3 of the invention disclosure, which is attached as Exhibit C. The invention disclosure was prepared and witnessed prior to October 23, 2001. Dates, personal information, and other information not relevant to the substantiation of invention have been redacted from the copies included in Appendices A and C.

3. We hereby declare that all statements made herein of our own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application of any patent issued thereon.


Edward Litwinski

Rahmatollah F. Toosky

In re: Edward Litwinski, Rahmatollah F. Toosky
Appl. No.: 10/145,342
Filed: May 14, 2002
Page 2 of 2

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Edward Litwinski

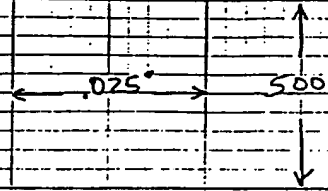
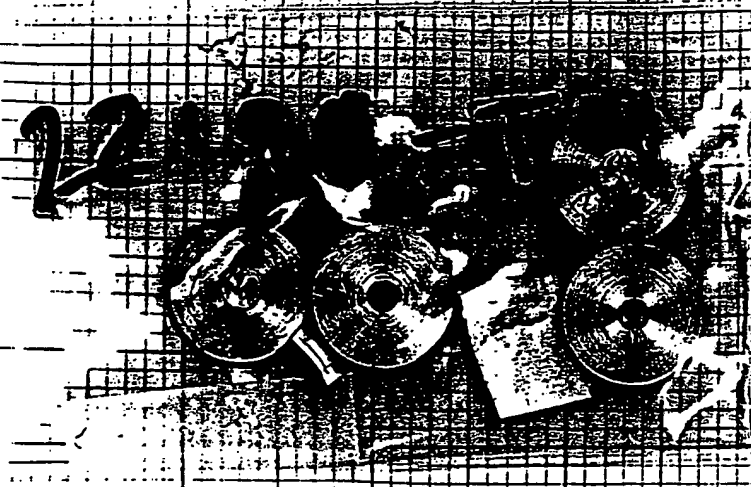
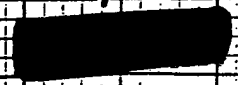


Rahmatollah F. Toosky

CLT01/4700567v1

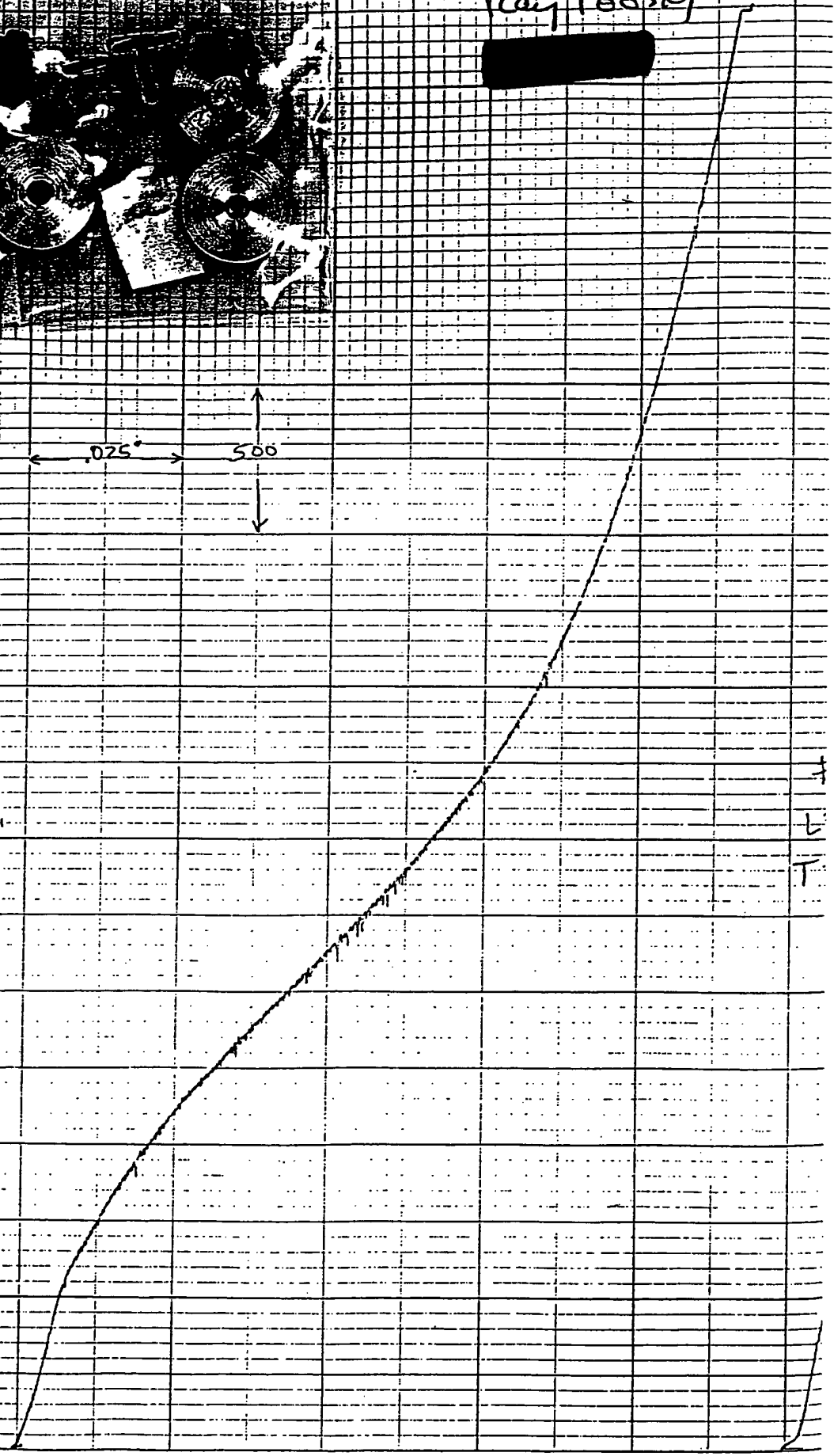
2219

Ray Tooling



2219-T4
#1 L=3.110"
T=1.575"

500 lbs/in

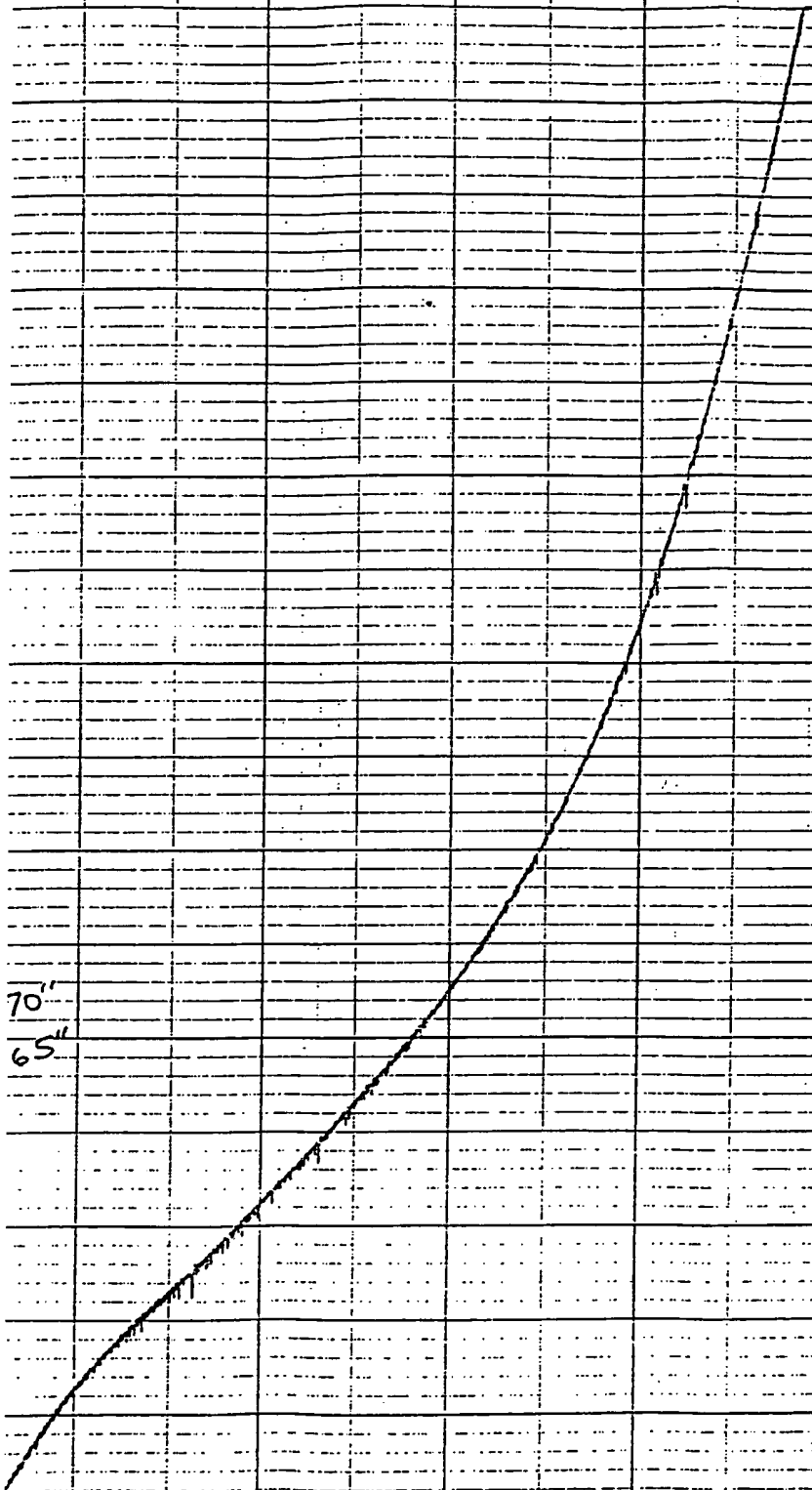


0.025"/in

NO. NY 1101 5PM

-7.4

70"
65"



[REDACTED]

5000

2219-T4

Ray Toosik

NO. XY 1101 SP4

1 AD 001, III

2500

NO 1

2000

1500

1000

500

.025"

500lb.

NO

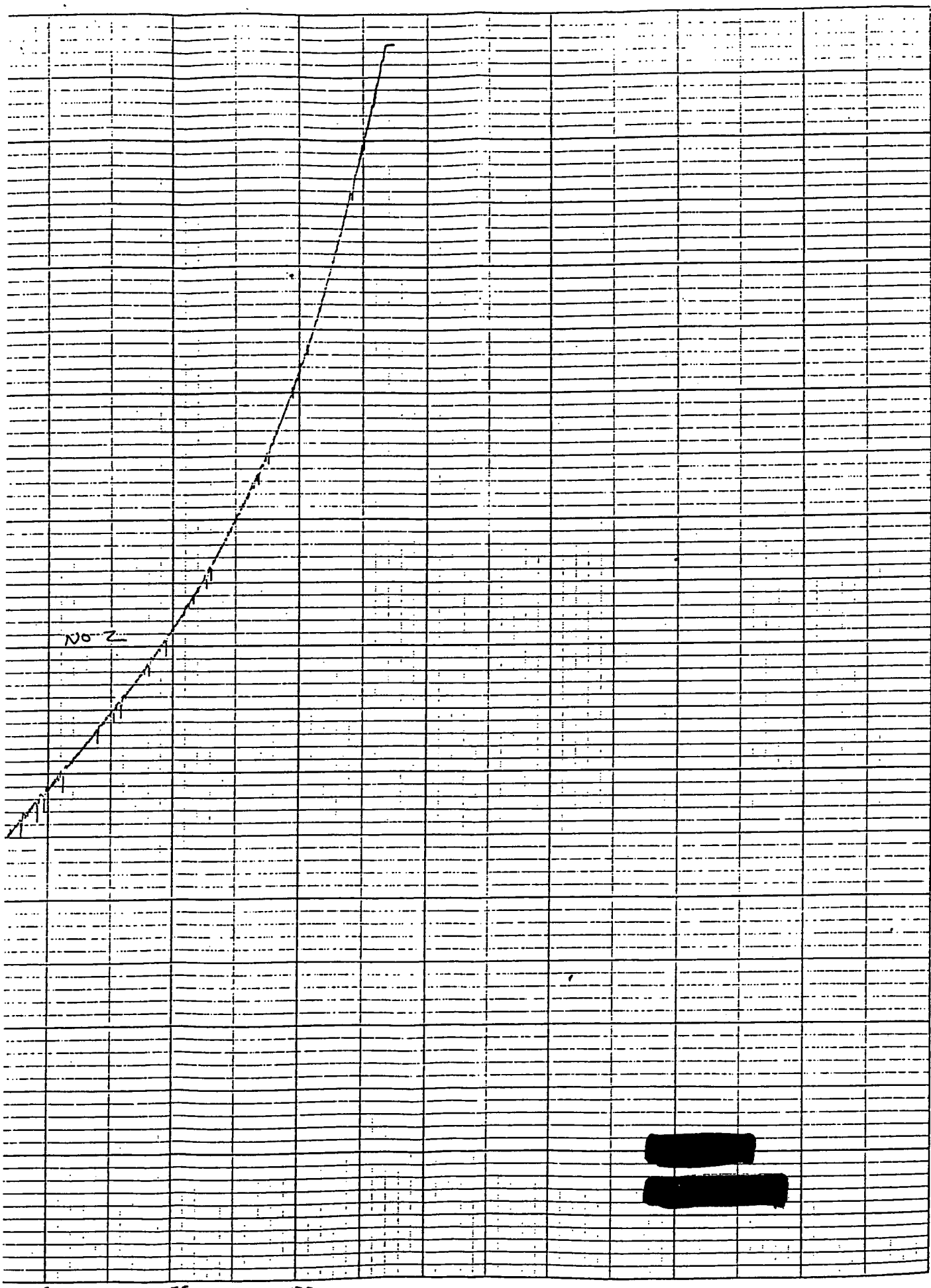
(2)

L = 314.7

T = .1555

#1
2195-T4

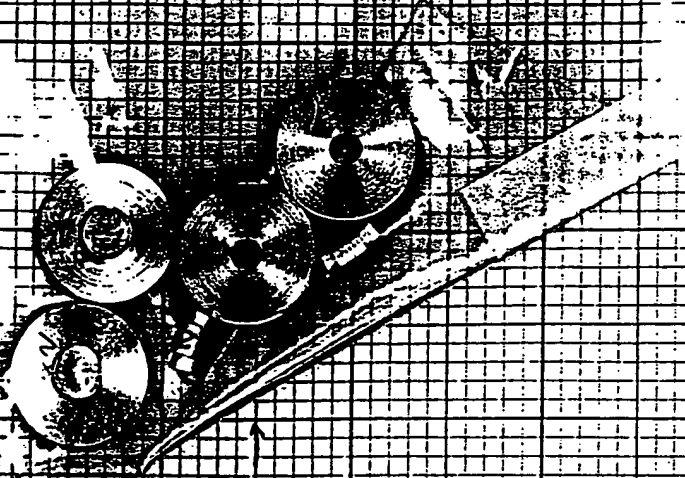
#2
2195-T4 .025



2219

2219-T6

2219



5.66

0.25"

2219-T6

L = 31.75"

T = 1.565"

#2

L = 31.60

T = 1.565

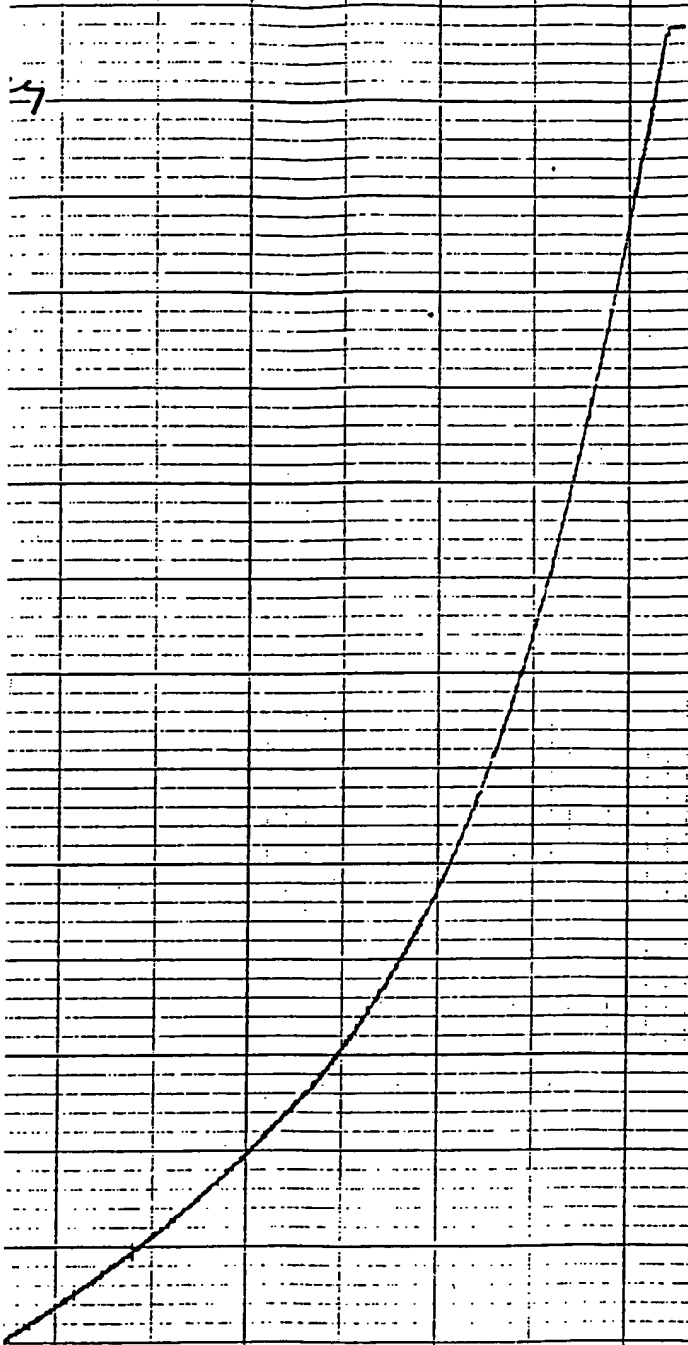
NO. XY 1101-SP4

500 lbs/in.

.025"/in.

-T6

4



[REDACTED]

Scin

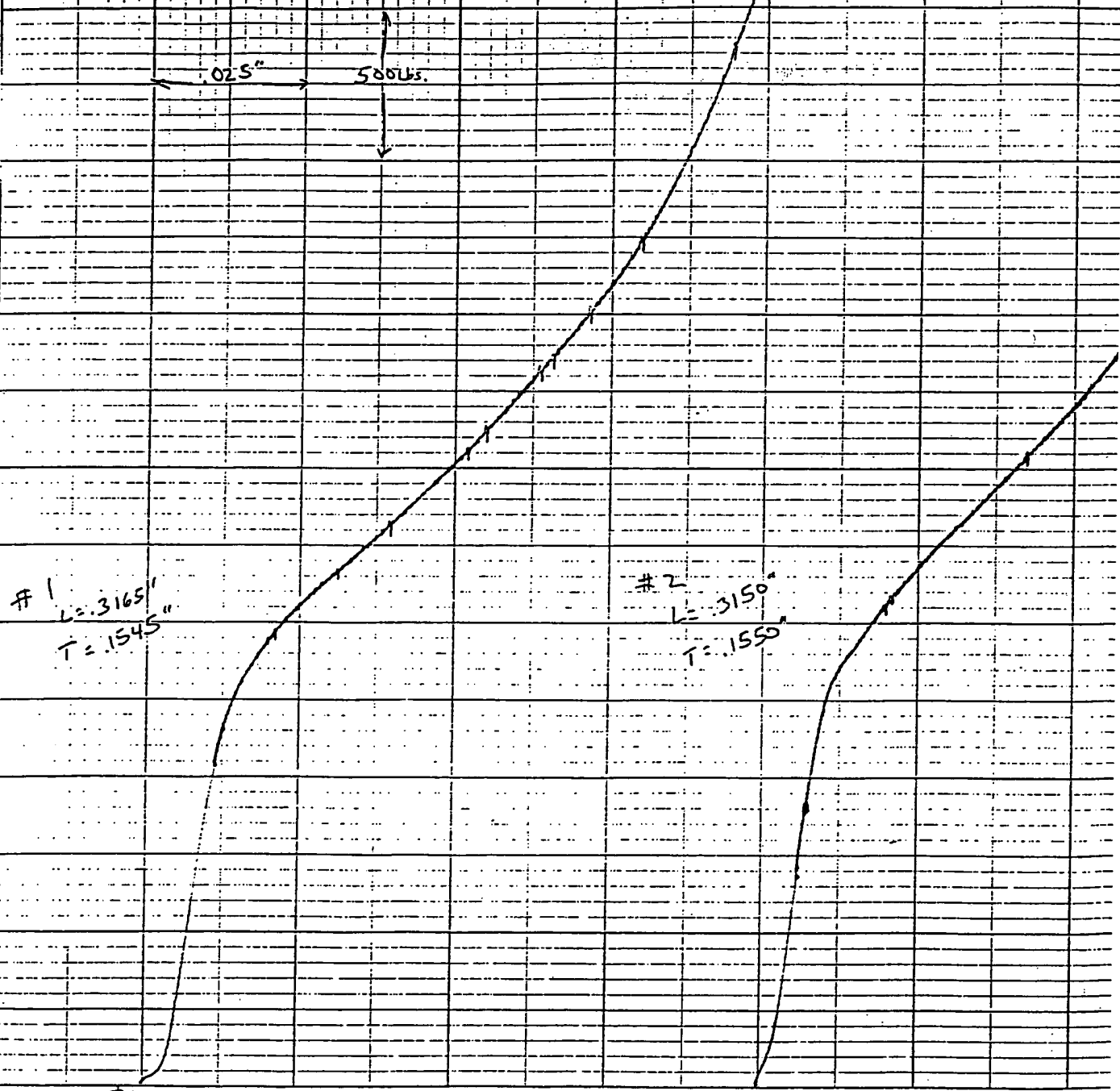
2195-T6

Ray Tooley



.025"

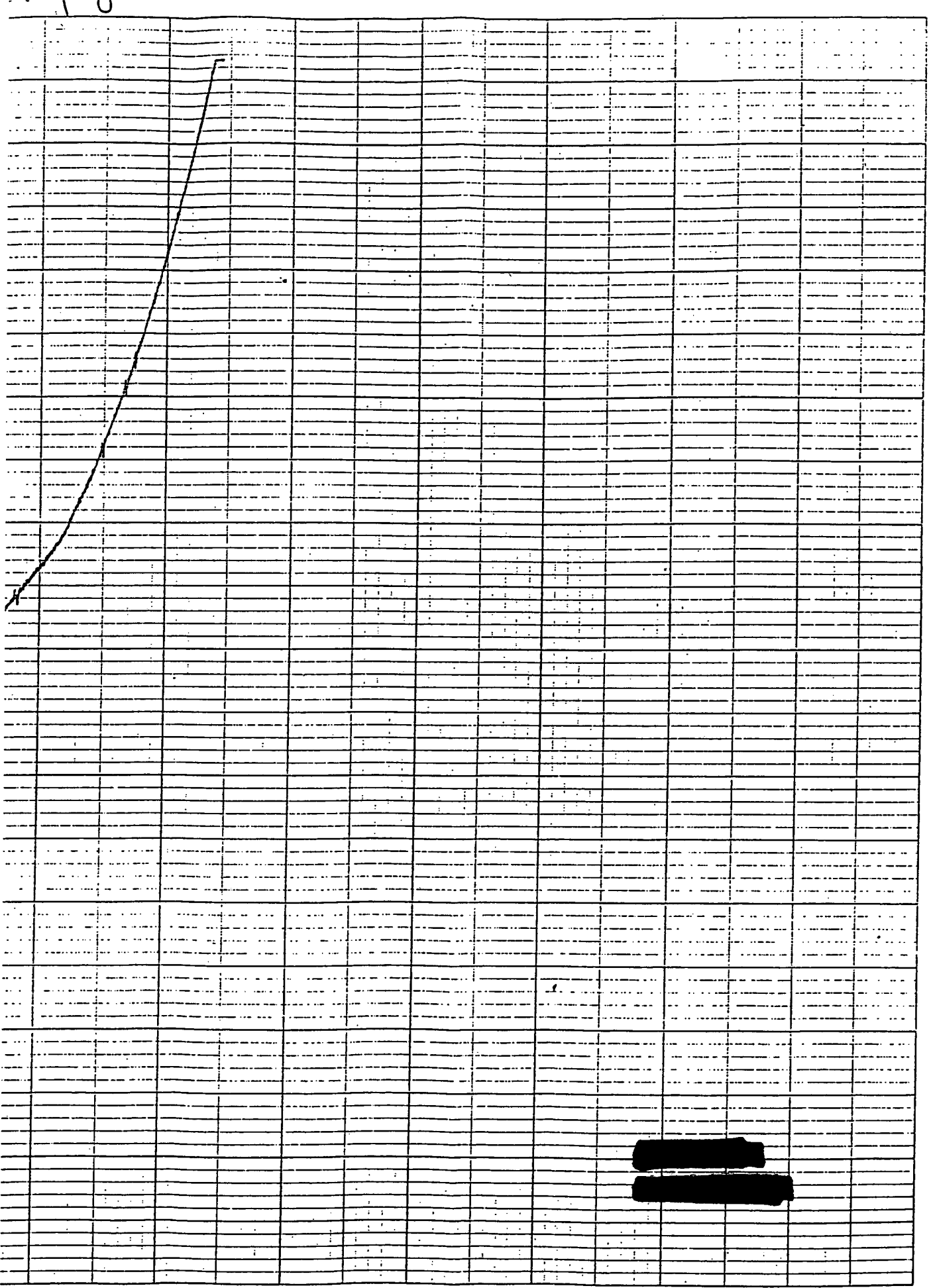
500lbs.



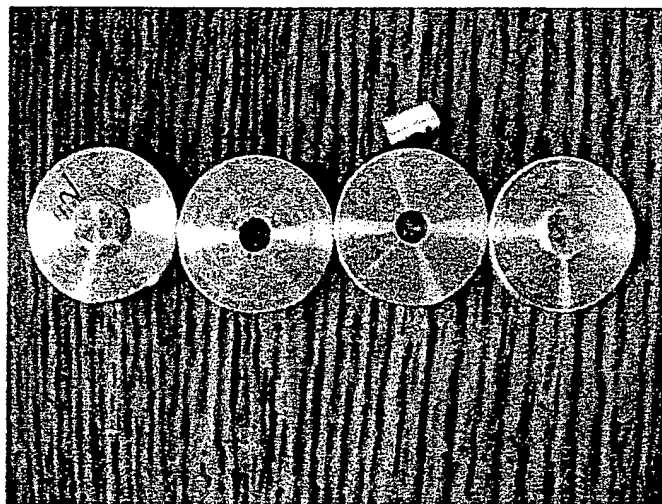
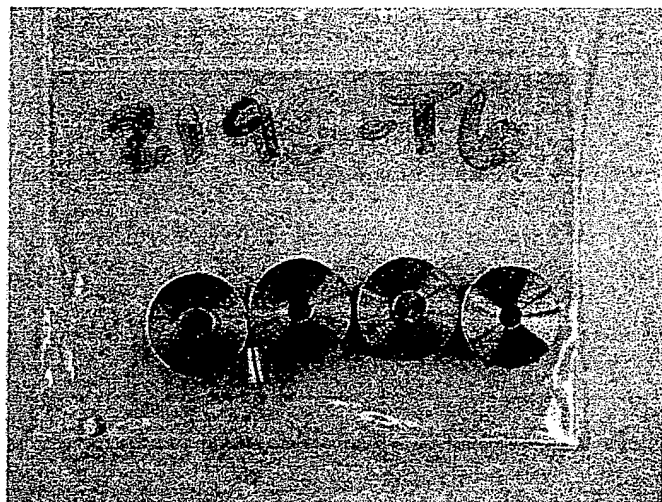
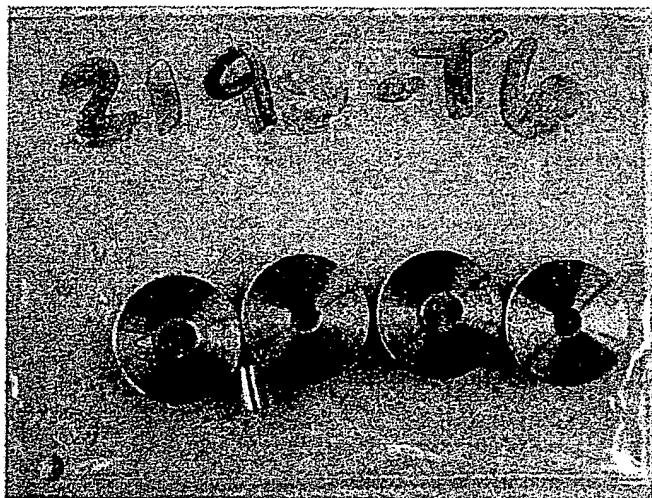
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2195-T6

2195-T6

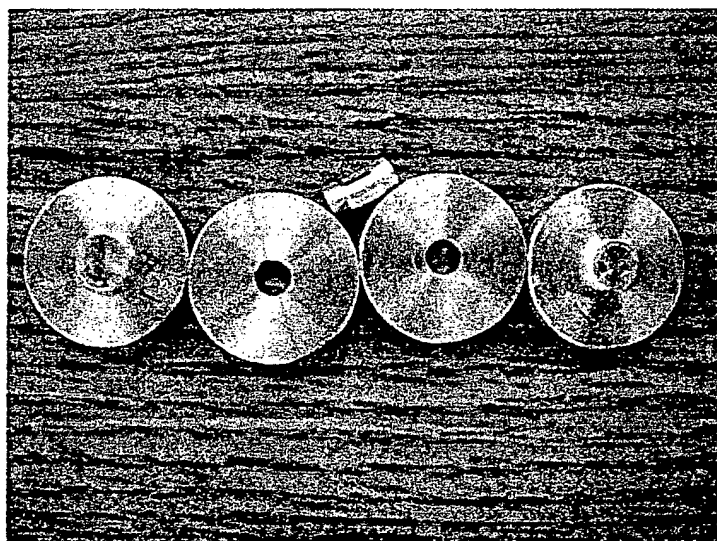
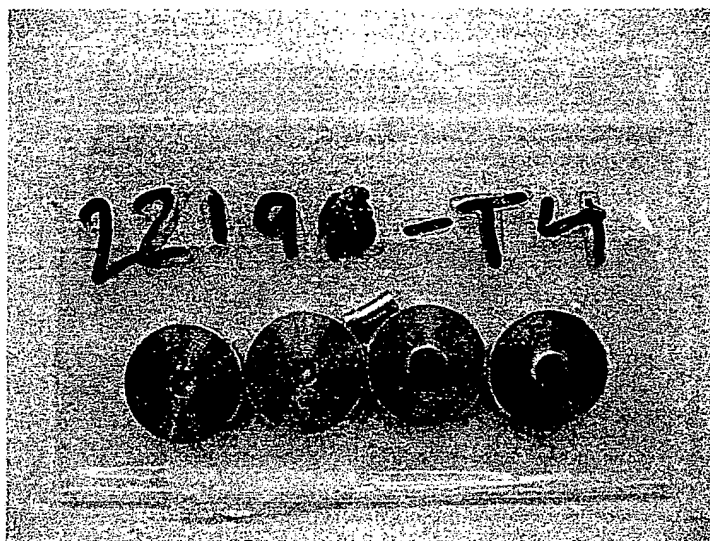
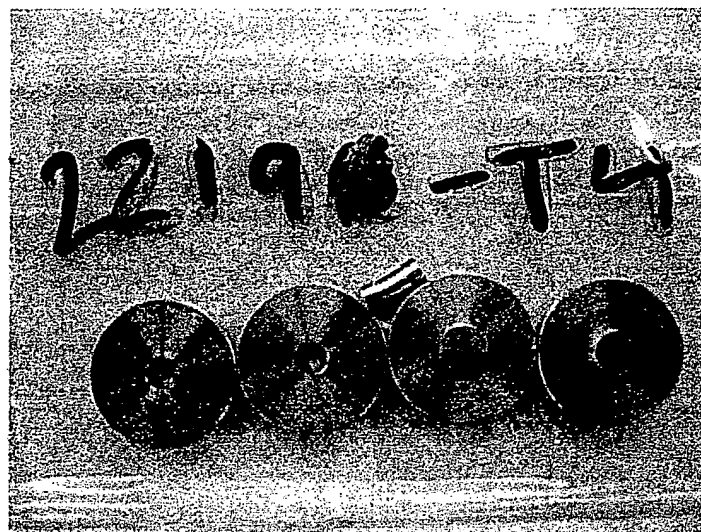
.025



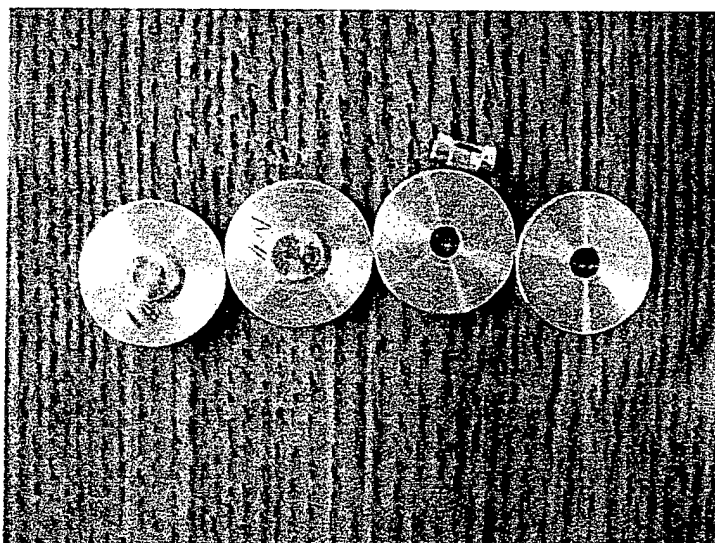
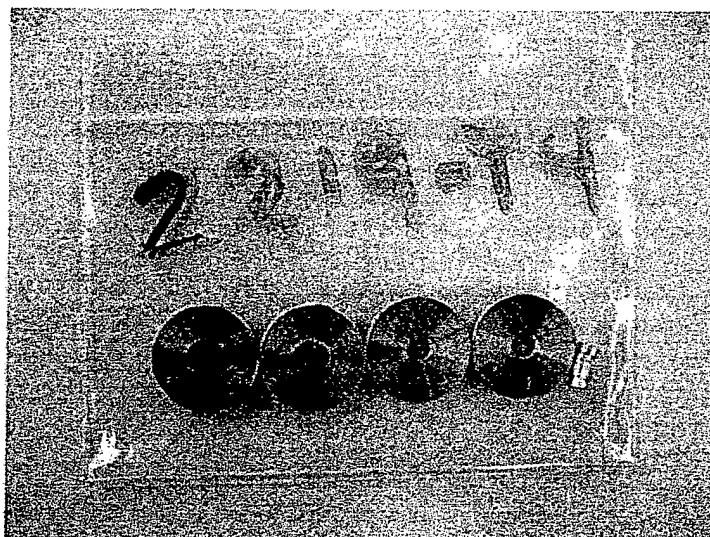
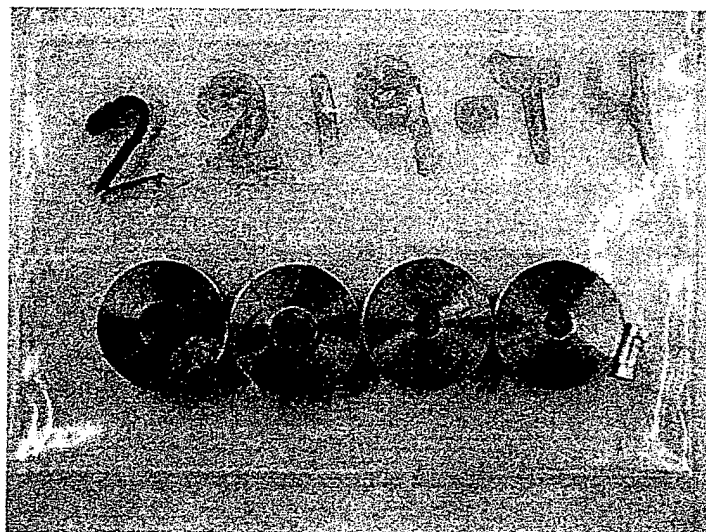
2195-T6



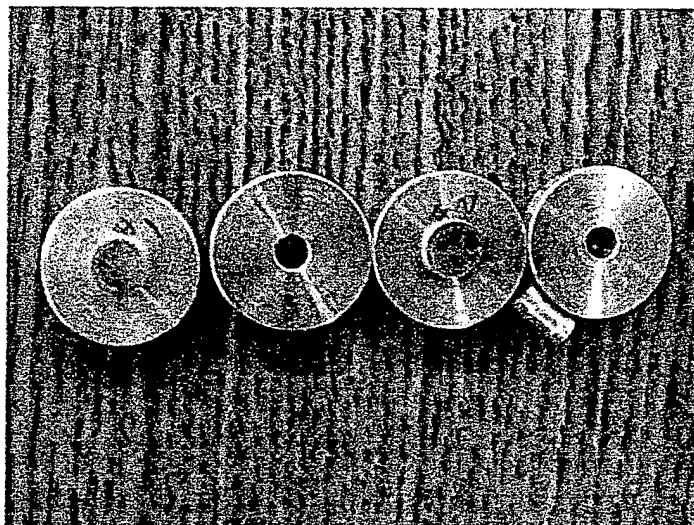
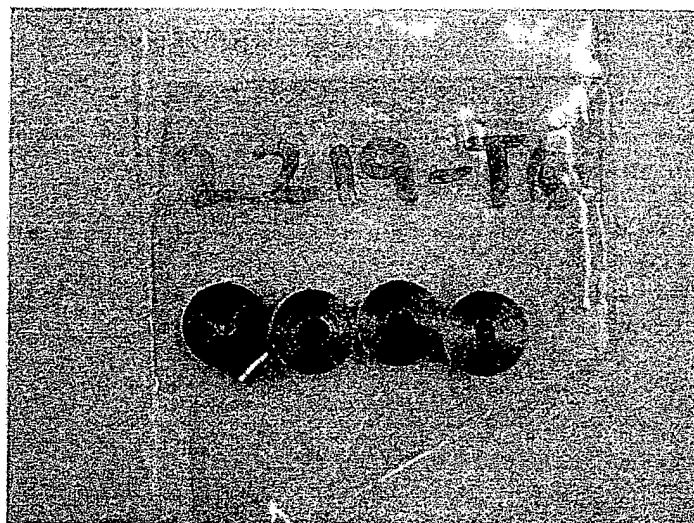
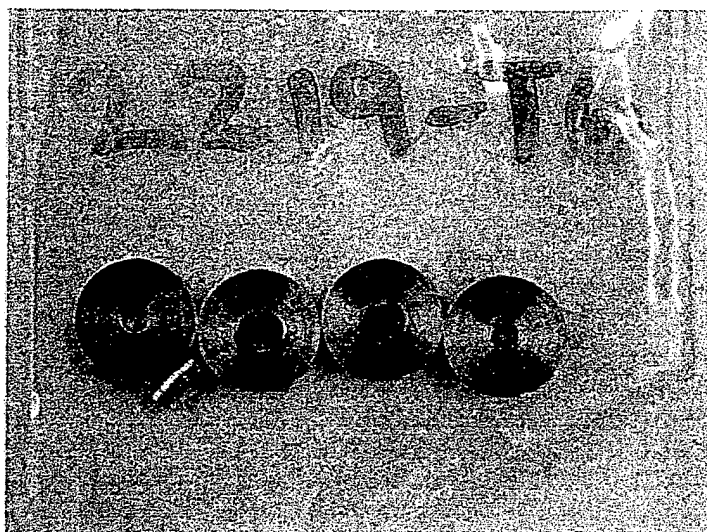
2219-T4



2219-T4



2219-T6



INVENTION DISCLOSURE

This form is to be used for disclosure to The Boeing Company of inventions, discoveries, improvements or innovations, whether or not considered patentable.
See above for instructions.

TITLE OF INVENTION (Descriptive and Concise)

Super Plastic Rivet Material.

INVENTOR INFORMATION (Use Additional Sheet If Necessary)

INVENTOR NAME (FIRST, M.I., LAST) 1	INVENTOR NAME (FIRST, M.I., LAST) 2	INVENTOR NAME (FIRST, M.I., LAST) 3	INVENTOR NAME (FIRST, M.I., LAST) 4
Edward Litwinski	Rahmat F. Toosky		
SOCIAL SECURITY NO. [REDACTED]	SOCIAL SECURITY NO. [REDACTED]	SOCIAL SECURITY NO.	SOCIAL SECURITY NO.
ORG. NO. [REDACTED]	MAIL STOP [REDACTED]	ORG. NO. [REDACTED]	MAIL STOP [REDACTED]
PHONE [REDACTED]	PHONE [REDACTED]	PHONE	PHONE
BOEING EMPLOYEE (ADD SUBSIDIARY) <input type="checkbox"/> Boeing <input type="checkbox"/> MDC <input checked="" type="checkbox"/> BNA <input type="checkbox"/> CONTRACT EMPLOYEE <input type="checkbox"/> OTHER (SPECIFY)	BOEING EMPLOYEE (ADD SUBSIDIARY) <input type="checkbox"/> Boeing <input checked="" type="checkbox"/> MDC <input type="checkbox"/> BNA <input type="checkbox"/> CONTRACT EMPLOYEE <input type="checkbox"/> OTHER (SPECIFY)	BOEING EMPLOYEE (ADD SUBSIDIARY) <input type="checkbox"/> Boeing <input type="checkbox"/> MDC <input checked="" type="checkbox"/> BNA <input type="checkbox"/> CONTRACT EMPLOYEE <input type="checkbox"/> OTHER (SPECIFY)	BOEING EMPLOYEE (ADD SUBSIDIARY) <input type="checkbox"/> Boeing <input type="checkbox"/> MDC <input type="checkbox"/> BNA <input type="checkbox"/> CONTRACT EMPLOYEE <input type="checkbox"/> OTHER (SPECIFY)
MANAGER'S NAME C.E. Silverman PHONE [REDACTED]	MANAGER'S NAME C.E. Silverman PHONE [REDACTED]	MANAGER'S NAME PHONE	MANAGER'S NAME PHONE

STATE OF DEVELOPMENT (See Remarks On Back)

DATE CONCEIVED [REDACTED]	<input type="checkbox"/> CONCEPT ONLY <input type="checkbox"/> PROVEN ANALYTICALLY <input type="checkbox"/> DESIGN COMPLETE	DATE BUILT [REDACTED]	DATE SATISFACTORILY TESTED [REDACTED]	<input type="checkbox"/> PROTOTYPE IN PRODUCTION _____ DATE
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APPLICATION OF THE INVENTION

PRODUCT/PROGRAM All riveted aluminum products	PRODUCTION RELEASE E.G. PRR NO.	DATE
POTENTIAL CUSTOMER(S) IN ADDITION TO BOEING [REDACTED]		

DISCLOSURE OF INVENTION OUTSIDE BOEING

DISCLOSED TO: <input type="checkbox"/> VENDOR <input type="checkbox"/> CUSTOMER <input type="checkbox"/> OTHER	NAME(S) None at this time	DATE(S)		
PUBLISHED <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO	PUBLICATION NAME	DATE	VOLUME NO.	PAGE

DEVELOPMENT HISTORY

1. WHAT BOEING ACCOUNT OR WORK ORDER WERE YOU CHARGING TO WHEN YOU MADE THIS INVENTION?
ACCOUNT OR WORK ORDER NO. FOR EACH INVENTOR (16-DIGIT CHARGELINE) 1) Personal Time
2) _____ 3) _____ 4) _____
2. CHECK AS APPLICABLE:
- ☐ THIS INVENTION WAS CONCEIVED OR FIRST BUILT AND TESTED IN THE COURSE OF WORK UNDER A U.S. GOVERNMENT CONTRACT.
CONTRACT NO. OR OTHER IDENTIFICATION _____
- ☒ THIS INVENTION WAS NEITHER CONCEIVED NOR FIRST BUILT AND TESTED IN THE COURSE OF WORK UNDER A U.S. GOVERNMENT CONTRACT.
- ☐ THE FOLLOWING ADDITIONAL PARTIES MAY HAVE RIGHTS TO THIS INVENTION: _____
3. RELATED INVENTION DISCLOSURE NOS: _____

DO NOT WRITE BELOW THIS LINE

DISCLOSURE NO.	DATE RECEIVED	DISCLOSURE ASSIGNED TO:	PE	IP
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BOEING PROPRIETARY

Introduction: Briefly introduce the subject associated with your invention.

Due to a lack of formability of high strength aluminum alloys in the hardened condition, a rivet manufacturing requires forming the rivet head in a soft condition, heat treating the rivet. Although there are a wide range of material issues associated with rivet material selection, the predominant factors are the materials bucking ability (formability) and the shear strength. There are many aluminum alloys with desirable shear strength, however, they tend to fracture during installation.

The friction stir weld process produces an ultra fine grain structure in the "nugget" area of the weld. Testing had determined that this nugget material has superior formability. Formability is known to be dependant on grain size. For example, as an indication of formability, the typical elongation of 2219-T4 is 20%. The elongation for 2219-FSW material was measured up to 29% and the 2195-FSW material was measured up to 21.5%. The increase in % elongation means an increase in formability of an alloy. This also applied to aluminum alloys with directional properties, for example the 2195 alloy, that have a lack of formability. Additional benefits include increased fatigue life, corrosion resistance and fracture toughness that should be applicable to all aluminum alloys, i.e. 2219, 2195, 7050, 7075 and 2017.

Problem Solved By This Invention: State the existing problem that is solved by your invention.

Response: The rivet manufacturing process can be shortened using fine-grain material instead of an annealed material. The rivet would be used in the "as-formed" condition. This would reduce the rivet manufacturing costs as well as eliminating the possibility of rivets being heat treated improperly.

Additionally, conventional mill products have limited formability, toughness and corrosion resistance. Lack of formability results in rivet cracking during forming operations. A lack of fatigue strength results in rivet fatigue cracks while in service. A lack of corrosion resistance results in premature failure.

Background: Describe the approaches that are currently used to solve or mitigate the existing problem. Additionally, describe the shortcomings associated with these approaches. Include any related patents or publications that you have knowledge of.

Response: Softer, lower strength material have been used to avoid cracking. The dimension or upset of the head is controlled to reduce cracking.

The rivets are typically coated for improved corrosion resistance.

Invention Description: Provide a detailed description of your invention, and illustrate it in a drawing, sketch, or a schematic (if susceptible to illustration). Correlate the illustration with the description by

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE				
WITNESSES SIGNATURES (AT LEAST TWO)		DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN [Signature]					SIGN [Signature]			
PRINT Kevin Ruth	PHONE [Redacted]				SIGN [Signature]			
SIGN [Signature]					SIGN [Signature]			
PRINT Rudoy LAURETTA	PHONE [Redacted]				SIGN			
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF)				DATE RECEIVED				

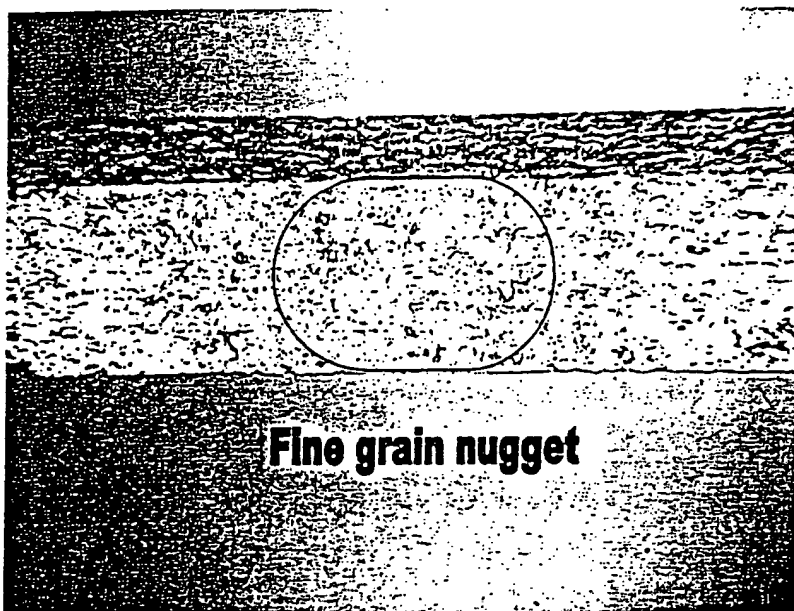
BOEING PROPRIETARY

using reference numerals and/or letters. Most importantly, clearly state the novelty of your invention (to the best of your knowledge). The invention description is likely to require more than one page of information.

Response: Testing had determined that the FSW nugget material has superior characteristics as a rivet material, such as increased toughness, increased fatigue life and increased corrosion resistance.

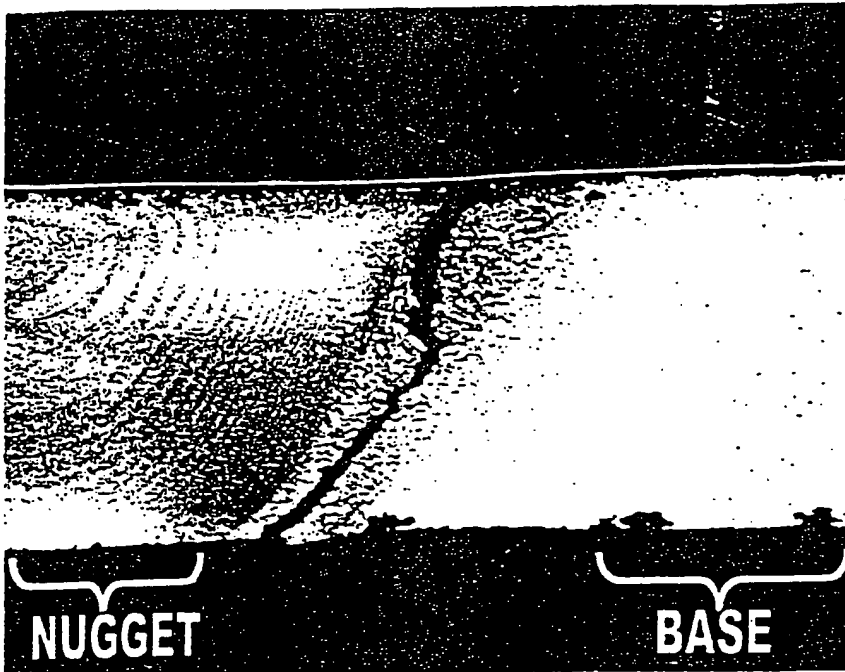
A load vs. displacement compression curve of 2219 and 2195 -T6 FSW nugget materials illustrated that these materials had much greater formability than materials presently produced.

Corrossion testing of a FSW specimen had determined that the nugget was less susceptible to corrossion than the base material. A cross section through a 2219-T6 tensile specimen that had been previously exposed to 90 days of alternate immersion testing determined that the nugget area had the least amount of corrosion attack. The maximum depth of pitting and intergranular attack in the unaffected base metal was twice as deep as the nugget material.



Overall view of 2219 tensile specimen after 90 days of alternate immersion testing. Circle indicates nugget area.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)		DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST
SIGN <i>Kevin Ruth</i>					SIGN <i>Robert H. Bell</i>		
PRINT Kevin Ruth	PHONE [REDACTED]				SIGN <i>Robert H. Bell</i>		
SIGN <i>Ruby Lauretta</i>					SIGN		
PRINT Ruby Lauretta	PHONE [REDACTED]				SIGN		
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF)				DATE RECEIVED			



View of cross section through 2219-T6 FSW tensile specimen (after testing). Note the area annotated as the nugget area has less corrosion as the base metal.



Detailed view of nugget metal corrosion.



Detailed view of base metal corrosion.

Technical Maturity: What is the state of development? Provide evidence that your invention concept has been sufficiently developed that there is little technology risk associated with its implementation. Results from analysis, simulation/modeling, or prototype testing are preferred.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE				
WITNESSES SIGNATURES (AT LEAST TWO)		DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN	<i>Kevin Ruth</i>	[REDACTED]			SIGN	<i>Edward H. Huh</i>		[REDACTED]
PRINT	Kevin Ruth				PHONE	[REDACTED]	SIGN	
SIGN	<i>Rudy Lauretta</i>	[REDACTED]			SIGN			
PRINT	Rudy Lauretta				PHONE	[REDACTED]	SIGN	
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF)			DATE RECEIVED					

BOEING PROPRIETARY

Response: Bucking ability on 2219 and 2195 FSW nugget materials determined that they had a desirable "upsetting" characteristics far beyond the traditional rivet materials. The tests showed that the rivets also had good hole filling characteristics and shear strength.

Technical Value: Provide evidence that your invention represents a significant advance in a technology area important to the success of Boeing, whether or not currently used. Quantitative data, such as trade study results, supporting the claimed benefits of your invention are preferred.

Response: Boeing is a major aerospace user of riveted products. The use of superior rivets will favorably affect the quality of our products. The formability and material properties is a significant improvement in the alloy without any weight gain. The ultra fine grained rivet material can be substituted for conventional rivet alloys without requiring a drawing changes. Present specifications permit this.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE				
WITNESSES SIGNATURES (AT LEAST TWO)		DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN	<i>Kevin Ruth</i>	[REDACTED]			SIGN	<i>Edward P. Hersh</i>		[REDACTED]
PRINT	Kevin Ruth				PHONE	[REDACTED]	SIGN	<i>Rahmat Toody</i>
SIGN	<i>Rudy Lauretta</i>	[REDACTED]			SIGN			
PRINT	Rudy Lauretta	PHONE			SIGN			
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF)			DATE RECEIVED					

BOEING PROPRIETARY

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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BOEING PROPRIETARY

BOEING PROPRIETARY

[REDACTED]

[REDACTED]

[REDACTED]

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE				
WITNESSES SIGNATURES (AT LEAST TWO)		DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN	<i>Kevin Ruth</i>	[REDACTED]			SIGN	<i>Edward J. [illegible]</i>	[REDACTED]	
PRINT	Kevin Ruth	PHONE [REDACTED]			SIGN	<i>John at [illegible]</i>	[REDACTED]	
SIGN	<i>[illegible]</i>	[REDACTED]			SIGN			
PRINT	RUDY LAURETTA	PHONE [REDACTED]			SIGN			
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF)				DATE RECEIVED				

BOEING PROPRIETARY

To: Ed Litwinski
Rahmat F. Toosky

Mail: [REDACTED]

Subject: Boeing Invention Disclosure No. [REDACTED] "Highly Deformable, High Strength Rivet Material"

*****PERSONAL INFORMATION*****

Full Name: RAHMATOLLAH F. TOOSKY

Social Security Number: [REDACTED] Orgn _____ M/S _____

Work Phone: [REDACTED] Home Phone: [REDACTED]

Home Address: [REDACTED]

City: [REDACTED] County: [REDACTED]

State: [REDACTED] Zip Code: [REDACTED]

Country: [REDACTED] Citizenship: [REDACTED]

Mailing Address:
(if different) _____

Employee Type: Salaried: _____ Hourly: _____ Non-Boeing [REDACTED]

Company (if Non-Boeing) _____

*****ADDITIONAL INFORMATION (if known and appropriate)*****

1. Actual or projected date of first use by Boeing or others:

2. Actual or projected date of publication (outside of Boeing) of concepts or other information relating to the invention:

3. Useful descriptive materials (documents, drawings, test results, etc.);

See Attachments of Test DATA

____ Copy included _____ Will furnish upon request

[REDACTED]
(Date)

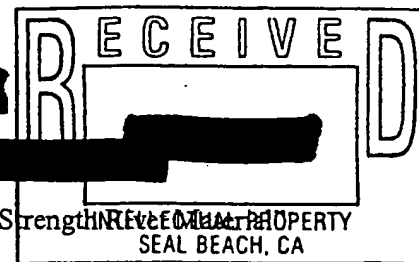
Rahmat Toosky
(Signature)

IP GROUP INTERNAL ROUTING

- 1 copy of completed form to U.S. Patent Administrator
- 1 copy of completed form to Patent Engineering
- 1 copy of completed form plus any attachments to outside law firm, if applicable

To: Ed Litwinski
Rahmat F. Toosky

Mail: [REDACTED]



Subject: Boeing Invention Disclosure No. [REDACTED] "Highly Deformable, High Strength [REDACTED]"

*****PERSONAL INFORMATION*****

Full Name: Edward Litwinski

Social Security Number: [REDACTED] Orgn. [REDACTED] M/S [REDACTED]

Work Phone: [REDACTED] Home Phone: [REDACTED]

Home Address: [REDACTED]

City: [REDACTED] County: [REDACTED]

State: [REDACTED] Zip Code: [REDACTED]

Country: [REDACTED] Citizenship: [REDACTED]

Mailing Address:
(if different) [REDACTED]

Employee Type: Salaried Hourly: _____ Non-Boeing _____

Company (if Non-Boeing) _____

*****ADDITIONAL INFORMATION (if known and appropriate)*****

1. Actual or projected date of first use by Boeing or others:

[REDACTED]

2. Actual or projected date of publication (outside of Boeing) of concepts or other information relating to the invention:

[REDACTED]

3. Useful descriptive materials (documents, drawings, test results, etc.);

see attachments

____ Copy included

[REDACTED]

(Date)

____ Will furnish upon request

Edward Litwinski

(Signature)

IP GROUP INTERNAL ROUTING

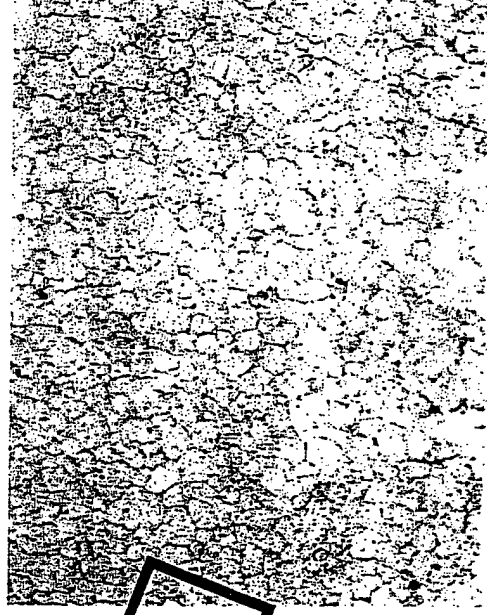
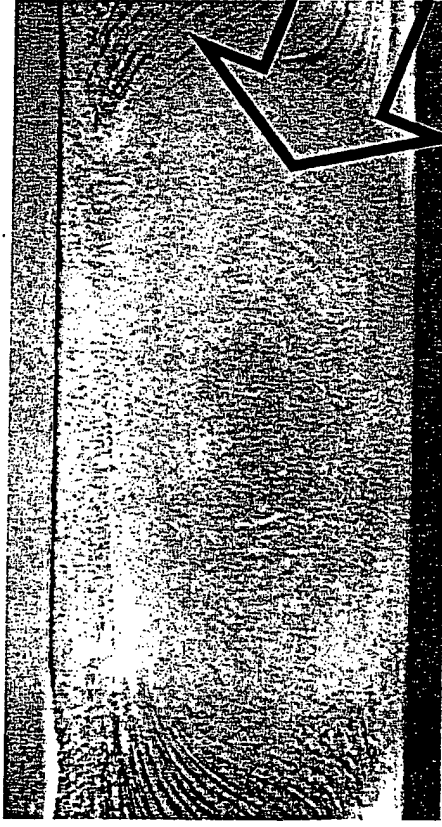
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- 1 copy of completed form to Patent Engineering

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Highly Deformable, High Strength Rivets

The nugget of a FSW has a very fine grain structure

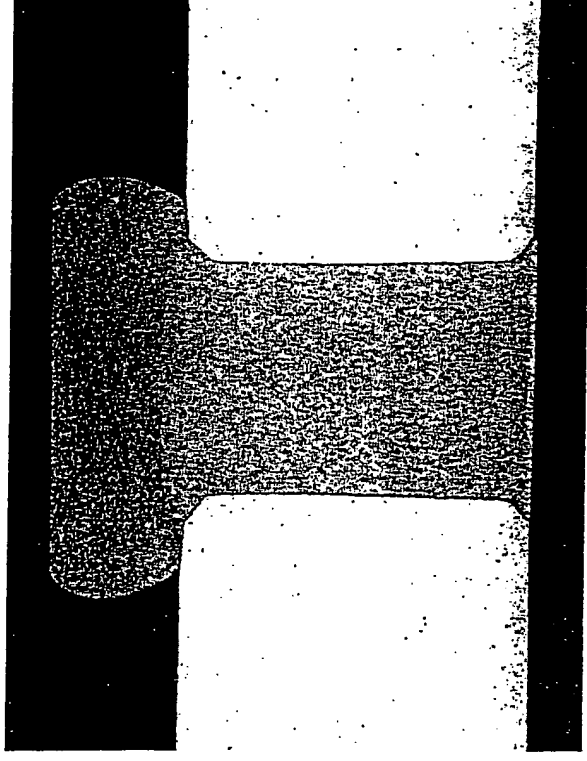


Fine grain size is known to increase toughness, fatigue strength and corrosion resistance.



Conventional Rivet Technology

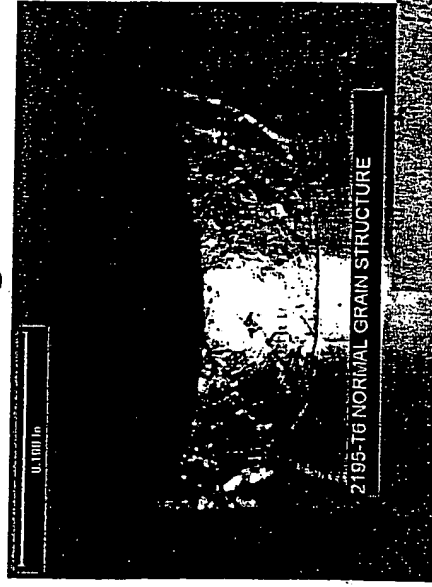
- Rivet materials had been chosen due to their ability to “upset” without cracking. The 2117-T4 alloy has been the conventional rivet alloy of choice.
- The increase in its ability to upset is related to its lack of strength



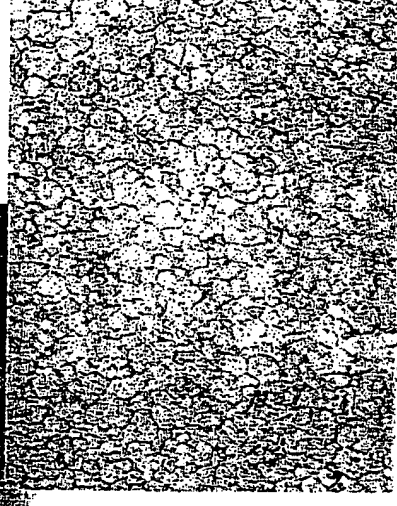
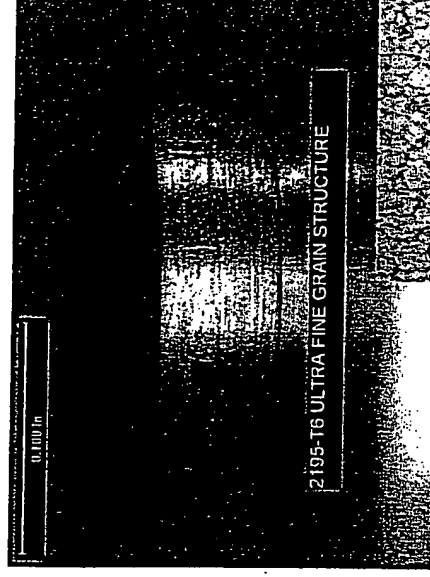
2117-T4 Material

Conventional Al-Li Alloys

- Al-Li alloys are high strength alloys with reduced weight (approximately 4.5% less). However, the higher strength does not allow the alloy to “upset” without cracking.
- The fine grain FSW nugget material can upset without cracking.



2195-T6 Material



2195-T6 (FSW) Material

Traditional Rivet Alloy Properties

- The 2195-T6 (FSW) material has better properties than conventional rivet materials.
- The process was not optimized. It is expected that with process improvements the properties could be improved to exceed conventional alloy properties with improved “upset”, toughness, fatigue and corrosion properties.

Alloy Data Summary

Alloy	Weight, lbs/in ³	Ult. Tensile, ksi	Yield Strength, ksi	%Elongation	Shear, ksi
2195-T6 (FSW)	0.097	Not Available	Not Available	Not Available	38-41
2195-T6	0.097	73	66	10	45
2017-T4	0.101	62	40	22	38
2117-T4	0.099	43	24	27	28
7050-T7	0.102	74	65	13	41
7075-T7	0.101	73	63	13	37

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